

Corbula tarasconii, a new species of Corbulidae (Bivalvia) from offshore Brazil

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ABSTRACT

Corbula tarasconii, a new species of Corbulidae is described from material collected along the Brazilian coast. No living specimens are known and only shell characters were compared with the most similar *Corbula* species from the western Atlantic and eastern Pacific oceans. Short, ventrally curving rostrum and sculpture of low, rounded commarginal ribs having their bases about three times broader than the interspaces are the most important diagnostic characteristics of *C. tarasconii*. These characters distinguish the new species from other western Atlantic and eastern Pacific Corbulidae.

Additional Keywords: *Corbula tarasconii*, Corbulidae, Bivalvia, taxonomy, Brazilian littoral, new species.

INTRODUCTION

During a research project carried out by the two senior authors on *Corbula* Bruguière, 1797, occurring in Brazilian sea waters, specimens of an unknown species were found in samples made at four different localities between southern Bahia state and northern Rio de Janeiro state. Working independently, the last two authors found the same unknown bivalve among the benthic fauna collected during field research on the continental shelf of northern Bahia state. Careful examination of all specimens gathered by the four authors, plus comparison with the nominal species hitherto published in the literature, led to us to conclude that the specimens represent a new species.

Corbulids are readily recognized by their small size (usually less than 20 mm in shell length) and their inequivalve condition, with the right valve larger, more convex, and overlapping the left one. All corbulids are shallow-burrowing suspension feeders inhabiting sandy, sandy-mud, or muddy substrata, usually at depths greater than 4 m (Lamprell et al., 1995).

Two living subfamilies of Corbulidae, Corbulinae

Lamarck, 1818, and Lentidiinae Vokes, 1945, encompass all extant (~85) species; a few tropical representatives live in brackish rivers and streams (Coan et al., 2000). Lentidiinae is represented by species of the single genus *Lentidium* Cristofori and Jan, 1832; Corbulinae is by far more specious and includes 25 genus-level taxa (Coan et al., 2000), among which *Corbula* is the largest. Keen (1969) previously subdivided *Corbula* into 18 subgenera, several of which were rather poorly defined and in need of revision, whereas authors such as Warnke and Abbott (1961), Abbott (1974), Bernard et al. (1993), Coan et al. (2000), Mikkelsen and Bieler (2001) and Anderson and Roopnarine (2003) elevated some subgenera to generic status, a decision not shared by Coan (2002). In this latter paper, Coan (2002), considered elevating subgenera to genera premature, because the arrangement of these taxonomic categories is still fraught with inconsistencies and additional characters need to be better defined.

The genus *Corbula* has long been a source of nomenclatural confusion and many authors have been attempted to resolve it. It is beyond the scope of this paper to discuss the systematics of the entire group once Coan (2002) has already presented a consensus based on the current rules of the International Code of Zoological Nomenclature (1999).

According to Mikkelsen (2004), there are 13 species of Corbulidae in the western Atlantic, eight of which were previously cited by Rios (1994) as occurring on the Brazilian coast: *Corbula* (*Corbula*) *caribaea* d'Orbigny, 1853, *C. (C.) lyoni* Pilsbry, 1897, *C. (C.) patagonica* d'Orbigny, 1846, *C. (C.) tryoni* E. A. Smith, 1880, *C. (Caryocorbula)* *cymella* Dall, 1881, *C. (Caryocorbula)* *dictyana* C. B. Adams, 1852, *C. (Juliacorbula)* *cubani-ana* d'Orbigny, 1853, and *C. (Varicorbula)* *operculata* Philippi, 1845. Revising *Varicorbula* from the western Atlantic, Mikkelsen and Bieler (2001) considered *C. (V.) operculata* cited by Rios (1975; 1985; 1994) as a synonymous with *V. disparilis* (d'Orbigny, 1842) or misidentified specimens of *V. philippii* (E. A. Smith, 1885).

In this contribution, we describe a new species of *Corbula* from Brazilian waters, based on shell characters only, because no living specimens were obtained, and we compare this new species with its most closely related species from Atlantic and Pacific waters.

MATERIALS AND METHODS

Twenty whole shells and 56 disarticulated valves (28 right and 28 left) of the new species were collected on the Brazilian continental shelf, between northeastern Bahia state (11°58.7' S, 36°49.2' W), and northeastern Rio de Janeiro state (21°20'28" S, 40°16'09" W). Shell morphology was compared with the most closely related species known from the western Atlantic and eastern Pacific, borrowed from the Departamento de Zoologia da Universidade de São Paulo, Brazil (one lot of *Corbula acquivalvis* Philippi, 1836, and one of *C. caribaea* d'Orbigny, 1853, both without catalog number), Museu de Zoologia da Universidade de São Paulo, Brazil (*C. bicarinata* G. B. Sowerby, 1833, lot MZSP 67964), and Santa Barbara Museum of Natural History, USA (*C. marmorata* Hinds, 1843, lots SBMNH 83076, SBMNH 131640, and SBMNH 141610). Shell characters and illustrations of *C. ira* Dall, 1908, provided by Coan (2002), were the basis for comparison with those in the new species.

The holotype and 14 paratypes were deposited in the malacological collection of the Museu de Zoologia da Universidade de São Paulo (MZSP), 15 paratypes in the Museu Nacional do Rio de Janeiro (MNRJ), and 46 paratypes were deposited in the Museu Oceanográfico Prof. Eliézer de Carvalho Rios (MORG).

SYSTEMATICS

Order Myoida

Family Corbulidae Lamarek, 1818

Subfamily Corbulinae Lamarek, 1818

Genus *Corbula* Brugnière, 1797

Subgenus *Caryocorbula* Gardner, 1926

Corbula tarasconii new species
(Figures 1–18)

Type Locality: Off Guarapari Municipality, Espírito Santo state, 20°45' S, 40°25' W, Brazil, 60–65 m depth.

Holotype: Museu de Zoologia, Universidade de São Paulo, MZSP 84452 (Figures 1–5, 8, 11).

Measurements: 7 mm length, 5 mm height, 4 mm width.

Paratypes: MZSP 84453 to 84461, northeast of Bahia state, 11°58.7' S, 36°49.2' W, 01 Nov. 2000, 100 m (MZSP 84453: 1 complete shell; MZSP 84454 to 84461: 6 right, 2 left valves); MZSP 84462 to 84464, southeast of Bahia state to Guarapari Municipality, Espírito Santo state, 15°33' S, 38°56' W to 20°45' S, 40°25' W (MZSP 84462–84464: 3 complete shells, 1 left valve); MZSP 86026, northeast of Rio de Janeiro state, 21°20'28" S,

40°16'09" W, Feb.–Mar. 1992, 139 m (1 complete shell); MNRJ 11146–11157, northeast of Bahia state, 11°58.7' S, 36°49.2' W, 01 Nov. 2000, 100 m (MNRJ 11146, MNRJ 11147: 2 complete shells; MNRJ 11148–11157: 5 right, 5 left valves); MNRJ 11040, southeast of Bahia state, 15°53'82" S, 38°31'09" W, 30 Apr. 1996, 66 m (1 right, 1 left valve); MNRJ 11812, off Guarapari Municipality, Espírito Santo state, Oct. 1992, 60–70 m (1 complete shell); MORG 50792, off Boipeba Municipality, Bahia state, 13°35'18.33" S, 38°54'48.27" W, Feb. 2003, 41–53 m (4 complete shells); MORG 50789, off Camamu Municipality, Bahia state, 13°55'58.79" S, 38°05'28.13" W, 11 Dec. 2002, 52 m (7 complete shells, 16 right, 19 left valves).

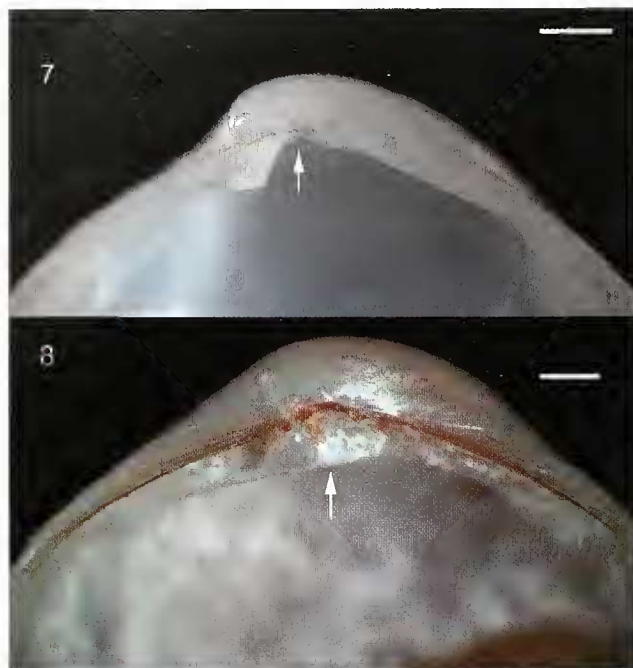
Diagnosis: Shell trigonal to trigonal-elongate, small (maximum length ~8 mm), thin to moderately thick, inflated, subequilateral, with a short rostrum, gently curving ventrally. Left valve smaller than right. Sculpture similar in both shell valves, comprised of low, regularly spaced rounded commarginal ribs crossed by minute, radially arranged pustules; base of commarginal ribs about three times broader than the intercostal spaces.

Description: Prodissoconch I and II markedly suborbicular. Prodissoconch I with a coarse and irregular surface texture under the SEM (length: 66.6 to 84.4 μ m, $n = 5$); prodissoconch II with subtle growth lines (length: 189.5 to 233.2 μ m, $n = 5$) and separated from the dissoconch by a sharp transitional line and change in sculpture on the latter. Dissoconch small (length: min. = 2.4 mm, max. = 8.11 mm, mean = 5.92 ± 1.36 SD [standard deviation]; height: min. = 1.7 mm, max. = 6.8 mm, mean = 4.48 ± 1.06 SD; $n = 47$; measurement taken from right valve), trigonal to trigonal-elongate, moderately thick in gerontic specimens, inflated, subequivalve, subequilateral with short rostrum.

Free margin of the right valve completely overlapping the entire free margin of the left valve. Rostrum acutely rounded, gently curved ventrally. Posterior slope of each valve narrow, slightly concave, forming an acute angle (~20°) between posterior dorsal margin and the low, rounded radial keel. Radial keel an inverted, gentle sigmoid line from umbo to the posterior limit of ventral margin; plane tangential to posterior slope forming a slightly obtuse angle with the plane tangential to central slope. Valve surface, excluding the posterior slope, regularly convex, except for a slight concavity in median-ventral area, just anterior to the keels. Umbos prosogyrous, at about 36% of shell length from anterior end, aligned with cardinal tooth on right valve and cardinal socket on left valve. Anterior dorsal margin straight, ventrally directed, continuous with evenly convex anterior margin, the latter situated below median longitudinal shell axis; posterior dorsal margin slightly convex, as long as, but less steep than the anterior dorsal margin; posterior margin long, obliquely truncated, and forming a short rostrum with posterior end of ventral margin; ventral margin evenly convex, except for a straight to slightly concave portion just anterior to the radial keel. Juvenile



Figures 1–6. *Corbula tarasconii*. 1–5. Holotype MZSP S4452. 1. Complete specimen viewed from the left valve. 2. External view of the right valve. 3. Internal view of the left valve. 4. Internal view of the right valve. 5. Dorsal view to show the posterior radial keels (broad arrow) and escutcheon (narrow arrow). Scale bar = 2 mm. 6. Paratype MNRJ 11154, external view of a translucent right shell valve showing minute pustules almost radially aligned (scale bar = 1 mm).

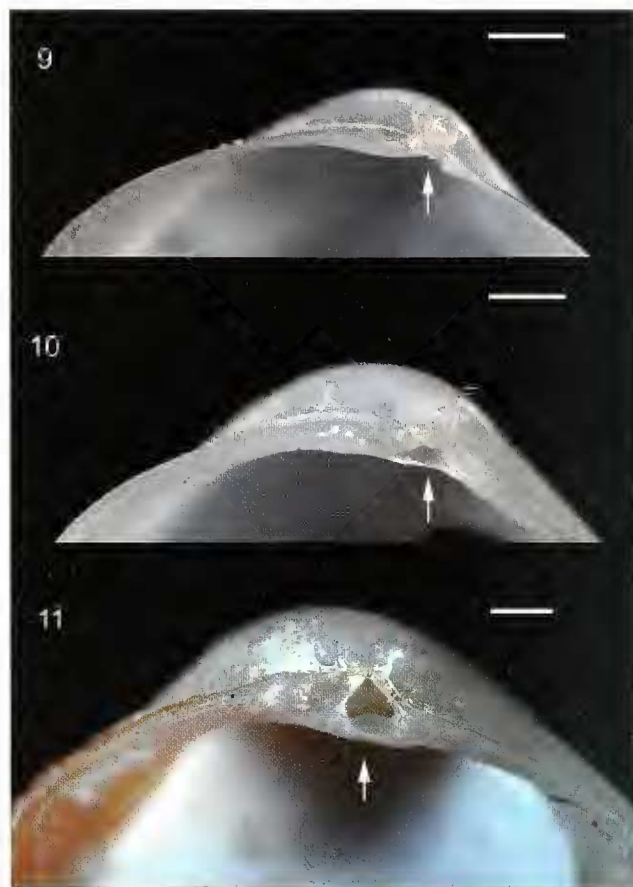


Figures 7–8. *Corbula tarasconii*. Hinge of the right valve of a thin-shelled specimen (7) and a thick, gerontic specimen (8), showing differences in the development of the hinge plate at the resilial socket region (arrow). **7.** Paratype MNRJ 11154. **8.** holotype MZSP 84452. Scale bar = 0.5 mm.

shells thin, whitish-translucent, turning moderately thick, and whitish-opaque as the specimens grow older; periostracum partially preserved on posterior slope, especially on left valve, missing on remaining shell area.

External sculpture similar in both shell valves, comprised of commarginal ribs crossed by minute pustules ($\sim 28.1 \mu\text{m}$ in basal diameter), the latter showing a tendency to align radially. Commarginal ribs regularly spaced, very low, rounded, with bases about three times broader than the intercostal spaces; commarginal ribs becoming moderately elevated lamellae on posterior slope of left valve only. Radial lines of pustules present all over shell surface, closer to each other on posterior slope; pustule lines visible through translucent shells. Area immediately in front of umbos sunken; lunule absent. Escutcheon lanceolate ($\sim 1/3$ of shell length), delimited on right valve by a low, rounded elevation on the posterior slope, and on left valve by a slender radial rib; this slender radial rib formed by confluence and abrupt decrease in height of adjacent commarginal ribs, the last extending onto umbo almost parallel to free margin of escutcheon. Inner surface whitish, porcelaneous, crowded with randomly scattered submicroscopic pustules ($\sim 16.5 \mu\text{m}$ in basal diameter), distinguished under SEM only.

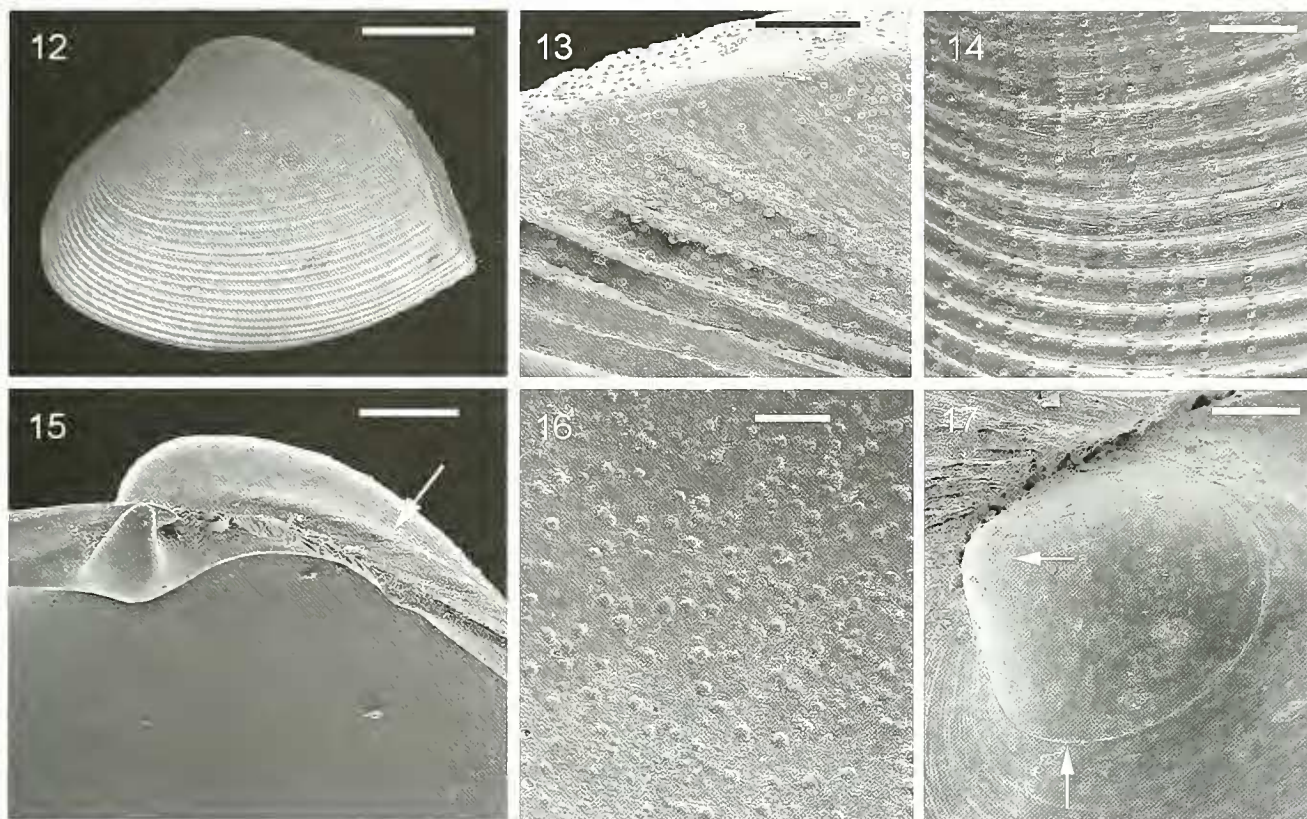
Hinge axis almost parallel to anterior dorsal margin. Right hinge plate with a cardinal tooth aligned with umbo, and a resilial socket sunken under umbonal region; cardinal tooth pyramidal, stout, with its apex curled dorsally, isosceles-triangle-shaped when viewed from its convex face; hinge plate narrow, deeply retracted at re-



Figures 9–11. *Corbula tarasconii*. Hinge of the left valve of thin-shelled specimens (9–10) and a thick, gerontic specimen (11), showing differences in the development of the hinge plate at the cardinal socket region (arrow). **9.** Paratype MNRJ 11150; **10.** Paratype MNRJ 11149; **11.** Holotype MZSP 84452. Scale bar = 0.5 mm.

silial socket region in thin-shelled specimens, becoming expanded, thick, and more evident as specimens grow older. Left hinge plate with a deep, trigonal cardinal socket just posterior to umbo, and a thick, short chondrophore projecting almost perpendicular to plane of hinge plate when viewed from its dorsal side; hinge plate narrow, deeply retracted at cardinal socket region in thin-shelled specimens, becoming expanded, thick, and more evident as specimens grow older. Dorsal face of the chondrophore shallowly excavated and divided into an anterior and a posterior trigonal area by a radially placed, shallow, narrow groove; posterior margin of posterior trigonal area becoming thicker and projecting as a stout, rounded, tooth-like knob as specimens grow older.

Inner face of the right shell valve bearing a well-impressed commarginal groove for reception of entire free margin of the left valve. Anterior adductor muscle scar ovate, slightly to well-impressed; posterior adductor scar rounded in frontal view, on top of a slightly to well-elevated callosity. Anterior and posterior pedal muscle scars conspicuous and fused dorsally with corresponding adductor muscle scar. Pallial line narrow, glazed, far



Figures 12–17. Scanning electron micrographs of *Corbula tarasconii*. **12–14.** Paratype MZSP S4454. **12.** External view of the left valve showing regularly spaced, low commarginal ribs (scale bar = 1 mm). **13.** Frontal view of the posterior slope to show pustules radially arranged and commarginal ribs turning into moderately elevate lamellae. Scale bar = 200 µm. **14.** Detail of central slope (external view) showing the tendency of the pustules to arrange themselves radially. Scale bar = 200 µm. **15–16.** Paratype MZSP S4456. **15.** Detail of the umbonal region and the hinge plate region of the right valve showing the low, rounded border of the escutcheon (arrow). Scale bar = 100 µm. **16.** Internal view to show the presence of randomly scattered pustules. Scale bar = 50 µm. **17.** Paratype MORG 50789, detail of the umbo to show the limit of both prodissocoench I and II (arrows). Scale bar = 62 µm.

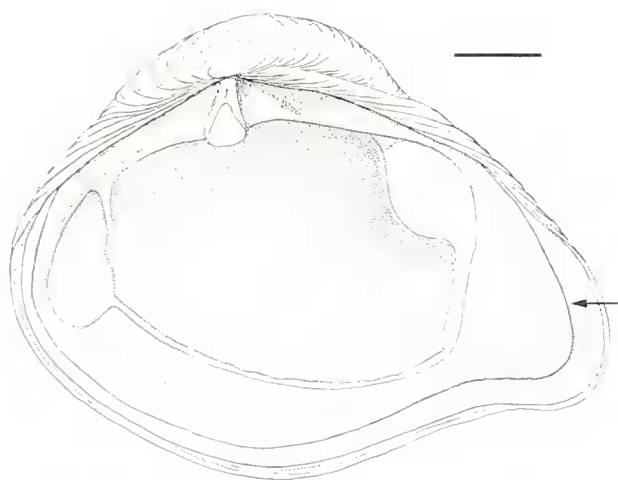


Figure 18. *Corbula tarasconii*. Paratype MZSP S4462. Camera lucida drawing of the inner surface of the right valve showing shell outlines, hinge, muscle scars and well impressed commarginal groove for reception of the free margin of the opposite valve (arrow). Scale bar = 1 mm.

from free border in both shell valves (farther in the right valve), especially in its anterior two thirds. Siphonal retractor muscle scar straight.

Etymology: This species is named after Dr. José Carlos Tarasconi, a physician interested in collection and molluscan studies, who kindly donated the specimen from his collection, herein designated as the holotype.

Observation: The holotype is the best preserved specimen among all complete ones; nevertheless, both shell valves have the postero-ventral portion of the ventral margin slightly broken. The brownish-red color viewed in the internal side of the holotype (Figures 3–4) was not observed among the paratypes.

Remarks: The presence in *Corbula tarasconii* of a small prodissocoench I (length: 66.6 to 84.4 µm), distinctly separated from the larger prodissocoench II (length: 189.5 to 233.2 µm), the latter devoid of surface ornamentation, except for growth lines. This suggests that the species has planktotrophic development, according to the discussions in Jablonski and Lutz (1980) and

Table 1. Shell characteristics in *C. tarasconii* compared with those in its closely related species from the western Atlantic and eastern Pacific oceans. Characteristics of *C. ira* are based on Conn (2002).^o

	Inequivalency	Shape	Rostrum	Keel	Sculpture		Siphonal plates	Escutcheon	Max. size (mm)	Distribution
					Commarginal	Radial				
<i>C. tarasconii</i>	subequivalve	trigonal to trigonal-elongate	short, ventrally curving	low, rounded	low, rounded ribs, with base wider than the intercostal spaces	pustulate	absent	RV—defined by low, rounded elevation; LV—defined by slender rib	7.2	western Atlantic, Brazil
<i>C. acquivalvis</i>	quite equivale	subrectangular	short	sharp, stout	low to moderately high ribs, with acute apex and base width equivalent to the intercostal spaces	absent	absent	defined by sharp, elevated ribs	16.6	western Atlantic
<i>C. caribaea</i>	subequivalve	trigonal-elongate	moderately to well produced, aligned with the anteroposterior shell axis	low, rounded	RV—low, slender to rounded ribs, with base narrower than the intercostal spaces; LV—low, moderately rounded ribs, with base width equivalent to the intercostal spaces	pustulate, present on the umbonal region only	present in most specimens	RV—defined by low, rounded elevation; LV—defined by slender rib	11.5	western Atlantic
<i>C. bicarinata</i>	quite equivale	subquadrate to trigonal	short	sharp	low to moderately high ribs, with acute apex and base width equivalent to the intercostal spaces	absent	absent	defined by sharp ribs	13.0	eastern Pacific
<i>C. ira</i>	subequivalve	ovate-subquadrate	short	sharp	strong, rounded ribs	fine ribs	mm	defined by ridge	13.6	eastern Pacific
<i>C. marmorata</i>	subequivalve	Trigonal-ovate	moderately to well produced, ventrally curving	rounded	strong, high ribs, with acute apex	absent	absent	defined by sharp ribs, more elevated on RV	8.2	eastern Pacific

^o mm = not mentioned; RV = right valve; LV = left valve.

Hain and Arnold (1992) on the relationships between prodissocoenchi morphology and modes of development.

This new species encompasses all diagnostic characteristics presented by Keen (1969) and Coan et al. (2000) both for the family Corbulidae and genus *Corbula*. Its subequivalve, trigonal to trigonal-elongate shell with moderately coarse commarginal ribs, similar on both shell valves allow the inclusion of this species in the subgenus *Caryocorbula* Gardner, 1926, as established by Anderson (1996) and Coan (2002). Beside these characteristics, *C. tarasconii* shares with *Caryocorbula* species a short chondrophore that projects almost perpendicular to the plane of the hinge plate when viewed from its dorsal side.

The allocation of *C. tarasconii* in *Caryocorbula* based in qualitative shell characters is an initial attempt to allocate the new species to one of the named subgenera. As observed by Anderson and Roopnarine (2005), *Caryocorbula* "is relatively conservative in its morphology, making qualitative methods for alpha-level taxonomy difficult." Subgenera of *Corbula* have been poorly defined and fraught with inconsistencies, and a full-scale revision of the family is long overdue (Coan, 2002). Much more studies are needed to gather new taxonomic characters, which could better define the subgenus-level categories of *Corbula* and corroborate whether *C. tarasconii* is correctly allocated to *Caryocorbula*.

Eighteen living species of *Corbula* are currently referable to the eastern Pacific (Coan, 2002) and thirteen to the western Atlantic (Mikkelsen, 2004). The western Atlantic species more closely related to *C. tarasconii* are *C. acquivalvis* and *C. caribaea*, and those of eastern Pacific water are *C. bicarinata*, *C. marmorata*, and *C. ira*.

Corbula tarasconii is distinguished from *C. acquivalvis* by being approximately 50% smaller in length, conspicuously inequivalve, with the posterior slope set off from the central slope by a low, rounded radial keel, sharp and stout in the latter species. The commarginal ribs in *C. tarasconii* are low, rounded, with the base about three times broader than the intercostal spaces and becoming lamellate on the posterior slope of the left shell valve, while in *C. acquivalvis* they are low to moderately high, each with a quite acute apex and basal width equivalent to the intercostal spaces. The narrow, lanceolate escutcheon, better demarcated in the left shell valve of *C. tarasconii*, is another remarkable difference distinguishing this new species from *C. acquivalvis*, which has a wide, lanceolate escutcheon, wider in the right valve, and well-demarcated in both valves by elevate ribs. The species can also be differentiated by the form and development of both the chondrophore and the right cardinal tooth. In *C. tarasconii*, the chondrophore has an inconspicuous to small tooth-like knob, and is shallowly excavated, with the dorsal face divided into two areas by a low, slender ridge; in *C. acquivalvis*, the tooth-like knob is larger and higher and the chondrophore is more projected from the free border of the hinge plate, with the dorsal face divided into two areas by a high

ridge, with the anterior area deeply excavated. Viewed from its convex face, the right cardinal tooth is right-triangle-shaped in *C. acquivalvis* and isosceles-triangle-shaped in *C. tarasconii*.

Corbula tarasconii greatly differs from *C. caribaea* by its short, ventrally curving rostrum that in *C. caribaea* is moderately to well produced and aligned with the antero-posterior shell axis. Viewed from its inner surface, the posterior margin of the rostrum, in most individuals of the latter species, has a sinuous outline; the rostrum is frequently extended farther posterior by lateral, siphonal plates made of calcified periostracum. The rostrum of *C. tarasconii* neither has sinuous outline nor siphonal plates.

The eastern Pacific *C. bicarinata*, compared to *C. tarasconii*, has an oval-subquadrate to trigonal outline, a shallow depression on the disc area farther anterior to the radial keel and aligned with the umbo-ventral axis, and the posterior slope set off from the central slope by a sharp, stout radial keel. The right cardinal tooth with a right-triangle shape and the wider, almost fan-shaped escutcheon, set off from the posterior slope by two stout, lateral ribs in *C. bicarinata* also differentiate it from *C. tarasconii*.

Based on the figures and description given by Coan (2002), the eastern Pacific *Corbula ira* is similar to *C. tarasconii* in outline, configuration of the retractor siphonal muscle scar, umbos position, but greatly differs in its larger size and disc area sculptured with strong, less numerous, rounded commarginal and fine radial ribs.

Corbula marmorata, the third eastern Pacific species closely related to *C. tarasconii*, has a more elongate, trigonal-ovate shell sculptured with strong, high, and acute commarginal ribs anterior to the radial keel. Both species share a shallow depression just anterior to the posterior radial keel and a short, ventrally curved rostrum, but the former species is also differentiated by the presence of a second shallow depression aligned with the umbo-ventral axis.

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